Environmental Performance Assessment Scheme for Hong Kong Buildings

John Burnett, BEng, PhD, CEng, FCIBSE, FIEE
Hong Kong Polytechnic University, Hong Kong Special Administrative Region, PRC

Summary

A dozen or so building environmental assessment methods are in use or under development worldwide. The HK-BEAM scheme, an initiative of the Real Estate Developers Association originally included versions for 'new' and 'existing' offices, and one for high-rise residential buildings. Since launch in 1996 over seventy major projects have been assessed, significantly raising the awareness of 'green buildings' locally. In recent years the Hong Kong SAR Government has promoted sustainable building through a number of initiatives, including changes to the building regulations, promoting energy efficiency, and in the management of indoor air quality. With sustainability given greater momentum it was recognized that the HK-BEAM scheme needed to be expanded and upgraded to cover a wider portfolio of building types, and to respond to higher performance expectations. This paper outlines the framework of the revised HK-BEAM scheme that is intended to be sufficiently robust to cover environmental performance assessments of various new designs and existing facilities, to which the marketplace can positively respond.

Introduction

Following in the footsteps of BREEAM [1] a dozen or more building environmental assessment methods (BEAMs) are in use or are under development worldwide. An initiative of the Real Estate Developers Association of Hong Kong was the introduction of 'new' and 'existing' offices versions of the Hong Kong Building Environmental Assessment Method (HK-BEAM) [2,3], based on the BREEAM approach. These were followed by an entirely new method for new high-rise residential buildings [4]. Since launch in 1996 over seventy major projects have been assessed, significantly raising awareness of 'green buildings' amongst local building construction and real estate professionals, and well as achieving some significant environmental gains.

In more recent years the Hong Kong SAR Government has promoted more environmentally sustainable building through a number of initiatives, including changes to the building regulations, promoting energy efficiency, and the management of indoor air quality. The 'sustainability movement' has certainly gained momentum in Hong Kong, even if really significant gains have yet to be realised. In such circumstance it was recognized by the HK-BEAM steering group that the scheme needed to be expanded and upgraded to cover a wider portfolio of building types, to include additional environmental aspects, and to respond to higher levels of performance. The 2003 versions of HK-BEAM for 'new' [5] and 'existing' [6] building developments are now in the pilot stage of implementation.

HK-BEAM Scheme

The 1996 versions of HK-BEAM for offices covered similar 'global', 'local' and 'indoor' environmental issues found in BREEAM, but modified to take into account the local circumstances, where high-rise office buildings with central HVAC

predominate. A major difference, however, is that assessment under HK-BEAM is finalized only when a new building is completed, or an existing building has completed any upgrading. The office documents were re-issued in 1999 with relatively minor modifications.

The real impact of implementing any BEAM is the extent of the environmental improvements that accrue, from the buildings assessed, and from raising performance standards throughout the building construction and real estate sectors. As of June 2003 some 26 assessments have been undertaken under the 'new offices' version covering 1.1 million m^2 of space [7]. 30 assessments have been undertaken under the 'existing offices' versions covering 1.9 million m^2 of office space.

The 'new' high-rise residential version of HK-BEAM launched in 1999, has a framework significantly different from the office versions in that it assesses at the estate level, as well as aligning itself with process: from planning through to commissioning and handover. Under this method assessment of 21 large residential developments has been undertaken covering 29,000 residential units, with take up by both the private and public sector developers.

Government Initiatives

The Hong Kong SAR Government has been active in environmental matters for many years mainly through the efforts of the Environmental Protection Department (EPD), but it is only in recent years has there been more focus on buildings. Currently, the only building energy efficiency regulation is the one governing Overall Thermal Transfer Value [8], but which has come under criticism for being neither appropriate nor sufficiently demanding [9]. The Electrical & Mechanical Services Department (EMSD) has taken initiative in respect of building energy efficiency through a

voluntary labelling scheme based on four codes of practice [10], although it should be mentioned that the energy codes for HVAC and lighting are not particularly demanding, although those for electrical installations and lifts and escalators are somewhat ground breaking. Demand side management [11] has also figured in EMSD's activities in collaboration with the local utilities, but given the lack of strong incentive under the current terms of control governing electricity supply, activity has been limited. Other initiatives include a pilot scheme for the wider use of fresh water in evaporative cooling towers, and studies on the potential applications of renewable energy, including photovoltaic applications to buildings.

Regulations with regard to lighting and ventilation in buildings administered by the Buildings Department (BD) are acknowledged to be outdated. The regulations, circa 1950's, have been particularly influential in the design of residential buildings, but hardly take account of their density and height, such as found in many estates (Figure 1). Realising the inappropriateness of the regulations the BD commissioned a study to develop alternatives, which has resulted in the issue of a practice note to allow for greater design flexibility [12]. BD in conjunction with other Government authorities has also issued two 'green building' initiatives in the form of Practice Notes [13,14]. These announce the possibility of significant incentives (exemption from Gross Floor Area and Site Coverage calculations) when design features such as sky gardens, wing walls, and solar shading devices, etc are included.

BD's initiatives are likely to be embraced with enthusiasm by developers given that incentives are attached, and are certainly welcomed by many architects looking to free-up estate layout and building design. However, the initiatives also require greater skills and use of more advanced techniques by designers, such as the use of wind

tunnels and/or computer modelling to assess wind pressures and street or podium level amplification [15].

Figure 1 A high-rise residential development in Hong Kong

EPD also has responsibility for some environmental aspects relating to building design and operation, including the management of ozone depleting substances, and the management of asbestos and legionnella. Indoor air quality (IAQ) is a current target through the development of a Certification Scheme covering air-conditioned buildings [16]. However, this initiative has caused a great deal of controversy given the demanding IAQ performance criteria and the detailed (and expensive) measurement protocol defined in the Guidance Notes [17] that underpin the scheme. A major issue is the compliance criteria set for metallic carbon dioxide (800 ppm for level 1, 1000 ppm for level 2), which cannot be met in many existing buildings without reducing occupancy levels or upgrading ventilation systems [18].

HK-BEAM 2003

The most significant feature of a BEAM is its framework, which needs to be robust enough to allow for sufficiently demanding assessment of new designs and/or existing facilities within a regime of continuous change, but at a level to which the

marketplace can respond [19]. Given that an assessment is voluntary, performance expectations need to balance ‘Green Building’ targets against practicalities, with enhancements over a timeframe that is acceptable to the market (Figure 2). In HK-BEAM the baseline performance or benchmarks are either regulatory compliance for some environmental aspects, or standard industry practice in the case of others. These change as legislation changes and the overall performance of the industry rises.

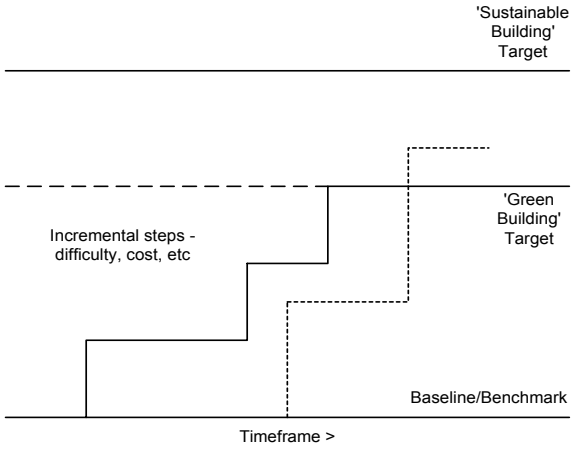

Figure 2 Setting performance targets under a BEAM

The environmental aspects covered in most BEAMs tend to be similar, but may be grouped under headings such as, ‘Resource Depletion’, ‘Environmental Loadings’, ‘Indoor Environment’ etc. Increasingly, there is the desire amongst scheme developers and users to include broader aspects of sustainable building, such as architectural quality, service quality, community value, etc. This is not unreasonable and a case can be made, provided there is a reasonable degree of objectivity in the assessment. In the revised versions of HK-BEAM environmental aspects are grouped as listed in Table 1. For HK-BEAM ‘new building developments’ credits can also be identified with the phases of planning and design, construction, and commissioning and handover. In HK-BEAM ‘existing building developments’ credits are also identified with management, operation and maintenance, and with building and system performance, respectively.

Table I Grouping of environmental aspects in HK-BEAM

P&D – Planning and design
CON – Construction
C&H – Commissioning and handover
MOM Management, operation & maintenance
B&S Building and system performance
* Maximum - depends on size/mix of premises/uses
Terminology is generally similar to that used in schemes elsewhere

Environmental Aspects	**4/03 'New'**		**Environmental Aspects**	**5/03 'Existing'**	
Site Aspects	**21***	Stage	**Site Aspects**	**21***	Facet
Urban Redevelopment	2	P&D	Land Use	2	B&S
Contaminated Land	1	P&D			
Local Transport and Amenities	2	P&D	Local Transport and Amenities	2	B&S
Site Design Appraisal	1	P&D	Environmental Management Policy	1	MOM
Ecological impact	1	P&D	Environmental Purchasing Policy	1	MOM
Landscaping and Planters	3	P&D	Landscaping & Planters	2	B&S
Microclimate Around Buildings	2	P&D			
Overshadowing and Views	1	P&D			
Vehicular Access	1	P&D	Vehicular Access	1	B&S
Construction Management	1	CON	Building Maintenance	2	MOM
Air Pollution During Construction	1	CON	Building Users Handbook	2	MOM
Noise During Construction	1	CON	Staffing Resources	1	MOM
Water Discharge During Construction	1	CON	Building Services O & M	4	MOM
Emissions from Wet Cooling Towers	1	C&H	Emissions Wet Cooling Towers	1	MOM
Noise from Building Equipment	1	C&H	Noise from Building Equipment	1	B&S
Light Pollution	1	P&D	Light Pollution	1	B&S
Materials Aspects	**22***		**Materials Aspects**	**13***	
Building Reuse	1	P&D	Building Reuse	1	B&S
Adaptability and Deconstruction	3	P&D	Adaptability and Deconstruction	3	B&S
Envelope Durability	1	P&D			
Modular and Standardised Design	1	P&D	Modular and Standardised Design	1	B&S
Off-site Fabrication	2	P&D	Off-site Fabrication		
Rapidly Renewable Materials	1	P&D	Rapidly Renewable Materials		
Sustainable Forest Products	2	P&D	Sustainable Forest Products	1	MOM
Green Building Materials	3*	P&D			
Use of Recycled Materials	2	P&D			
Ozone Depleting Substances	2	P&D	Ozone Depleting Substances	6*	B&S
Construction Waste	3	CON			
Waste Disposal and Recycling	1	P&D	Waste Disposal and Recycling	1	B&S
Energy Aspects	**33***		**Energy Aspects**	**29***	
Energy Use in Commercial Buildings	10*	P&D	Energy Use in Commercial Building	10*	B&S
Energy Use in Hotel Buildings	10*	P&D	Energy Use in Hotel Buildings	10*	B&S
Energy Use in Residential Buildings	8*	P&D	Energy Use in Residential Buildings	8*	B&S
Energy Use in Educational Establish.	8*	P&D	Energy Use in Educ. Establishments	8*	B&S
Maximum Demand Commercial Bldg	3*	P&D	Max Demand Commercial Bldg	3*	B&S
Maximum Demand in Hotel Buildings	3*	P&D			
Maximum Demand in Residential Blg	3*	P&D			
Maximum Demand in Educational Est	3*	P&D			
Ventilation Systems in Mech Vent Blg	2	P&D	Ventilation in Mech Vent Buildings	2	B&S
Interior Lighting in Mech Vent Blg	2	P&D	Interior Lighting in Mech Vent Blgs	2	B&S
Natural Ventilation in Premises	2	P&D	Natural Ventilation in Premises	2	B&S
Lift and Escalator Installations	1	P&D	Lift and Escalator Installations	1	B&S
Electrical Installations	1	P&D	Electrical Installations	1	B&S
Hot Water Supply	1	P&D	Hot Water Supply	1	B&S
Mech Ventilation in Hotel Buildings	1	P&D			
Positioning of Air-conditioning Units	3*	P&D	Position of Air-conditioning Units	3*	B&S
Clothes Drying Facilities	1	P&D			
Energy Eff. Lighting in Public Area	2	P&D	Energy Eff. Lighting in Public Area	2	B&S
Heat Reclaim Chillers or Heat Pumps	1	P&D			
Energy Efficient Appliances	1	P&D			
Embodied Energy	2	P&D			
Renewable Energy	5*	P&D	Renewable Energy	5*	B&S
Testing and Commissioning	4	C&H	Energy Auditing	5	MOM
O & M Provisions	3	C&H	Energy Management Manual	1	MOM

Metering and Monitoring	1	P&D	Metering and Monitoring	4	MOM
Water Use	**11**		**Water Use**	**10**	
Water Quality	1	C&H	Water Quality	1	MOM
Water Efficient Devices	2*	P&D	Water Efficient Devices	2	B&S
Metering and Controls	1	P&D	Metering and Controls	2	MOM
Water Efficient Irrigation	2	P&D	Water Management	2	MOM
Water Recycling	3	P&D	Water Recycling	2	B&S
Effluent	2	P&D	Effluent	1	MOM
Indoor Environmental Quality	**30***		**Indoor Environmental Quality**	**28***	
Thermal Comfort in A/C Premises	3	C&H	Thermal Comfort in A/C Premises	3	B&S
Thermal Comfort Naturally Ventilated	2	C&H	Thermal Comfort Nat Ventilated	2	B&S
Ventilation in A/C Premises	2	C&H	Ventilation in A/C Premises	2	B&S
Background Ventilation	1	C&H	Background Ventilation	1	B&S
Uncontrolled Ventilation	1	P&D			
Localised Ventilation	1	P&D	Localised Ventilation	1	B&S
Natural Ventilation in Public Areas	2	P&D			
Construction IAQ Management	2	CON			
Outdoor Sources of Air Pollution	4	C&H	Outdoor Sources of Air Pollution	4	B&S
Indoor Sources of Air Pollution	3	C&H	Indoor Sources of Air Pollution	3	B&S
Biological Contamination	1	P&D	Airborne Bacteria	1	MOM
Odours and Hygiene	2	P&D	Odours Control and Hygiene	2	MOM
Pollutant Source Control	2	P&D	Pollutant Source Control	2	B&S
Daylighting Windows and Views	4	P&D	Daylighting Windows and Views	4	B&S
Interior Lighting Design	3	P&D	Interior Lighting Performance	4	B&S
Room Acoustics	1	C&H	Room Acoustics	1	B&S
Noise Isolation	1	C&H	Noise Isolation	1	B&S
Background Noise	1	C&H	Background Noise	1	B&S
Indoor Vibration	1	P&D			
Innovations & Enhancements	**5***		**Innovations & Enhancements**	**5***	
Innovative Techniques	5*	Any	Innovative Techniques	5*	Any
Performance Enhancements		Any	Performance Enhancements		Any

The scoring system of points or credits awarded for each environmental aspect included should reflect as far as possible the environmental gain achieved, although this is not an easy matter to resolve given the diversity of impacts and changing priorities – in the future water may become more significant than energy, whereas CFC phase-out is becoming a thing of the past. In HK-BEAM, as for other schemes, the assignment of credits is largely based on consensus, including comparisons with other similar schemes, inputs from stakeholder, and professional judgement, but remains a significant feature for further refinement.

Likewise the overall assessment rating, such as ‘Gold’ or ‘Very Good’ needs to reflect overall environmental performance. In this regard, two problems arise. One is the way in which the total indoor environmental quality (IEQ, an output) is weighted against all others (inputs and emissions), to avoid the possibility that a ‘good’

assessment is obtained even if IEQ is unsatisfactory. There is the possibility of using a ratio (∑IEQ/∑others), as used in one method [20], but matching IEQ performance with overall performance is simpler, and is adopted in the latest HK-BEAM versions.

HK-BEAM now covers a range of building developments, from relatively small urban buildings to large residential estates, with a variety of buildings, premises and uses, both centrally air-conditioned and those designed to operate in a mixed-mode. Some environmental aspects will be marked 'not applicable' for some developments, resulting in variations in total score available. Clearly, 'Site Aspects' will vary somewhat with the scale and location of the development, as will 'Materials Aspects'. The relative significance of water use will depend on the type and use of premises. The most obvious variations come under 'Energy Use' and 'Indoor Environmental Quality'. Centrally air-conditioned buildings tend to be designed on the 'build tight, ventilate right' principle, but not so for buildings designed to utilise natural ventilation. In such cases energy use patterns will vary significantly, with thermal comfort and IAQ not well defined. In the HK-BEAM assessment of a large complex containing a mix of centrally air-conditioned and non-air-conditioned premises the credits available for each type of premises is weighted by floor area to arrive at an overall assessment for both 'energy' and for 'IEQ'.

In a BEAM the assessment of each aspect should be, as far as possible performance based, that is, quantifiable. An example is electricity use for air-conditioning in kWh m^{-2} $year^{-1}$. However, given the paucity of data available on many aspects, it is usual to included 'feature specific' assessments, features whose contribution to environmental performance can be appreciated but not easily quantified. An example is the provision of sub-meters for monitoring energy consumption. The assessment needs to strike a balance between being too prescriptive, as this tends to constrain ideas, and so broad

as to create problems for the assessor when trying to arrive at a decision on compliance.

To ensure actual gains are realised assessment of new building developments should be based as far as possible on actual performance, and finalised only after building handover. This is a significantly tougher regime than simply assessing at the design stage only (as practiced in many schemes), but one that ultimately brings more benefits to the Client, and to the environment. This approach also allows more emphasis to be placed on full commissioning and adequate provisions for operations & maintenance, often neglected and yet vitally important matters. It also means that the assessment for new buildings dovetails well with that for existing buildings, and provides a better coverage of life cycle performance.

For existing building developments assessment is complicated by the extent to which tenant/user occupied areas are include in an assessment. Access to tenant areas can be problematic and the activities of tenants within spaces can complicate some of the assessments, particularly IEQ aspects. Nevertheless, bearing in mind the assessment is of the building and systems, and not the users, it is possible to work around such problems by modifying the assessment method for particular aspects or in particular circumstances.

It is not unreasonable to build into the scheme a degree of flexibility, such as allowing Client's to submit proposals to allow alternative assessment methods. Likewise, HK-BEAM allows submission of proposals for assessment of initiatives not already included in the scheme, and also awards 'bonus' credits for innovations that enhance to performance. These count towards the award, but not the total of applicable credits, and are intended to encourage submission of really new ideas and innovations.

The consequence of this broad-based scheme in the increased complexity of the assessment scoring, but one which is tolerable given that the overall assessment outcome should reflect the size and type of the building development, and ultimately result in a fair overall grade.

Summary and Conclusions

The revised versions of HK-BEAM are thought to be as comprehensive as practice allows, offering the right balance of environmental objectives and targets for both new building developments and existing facilities. Although assessment is somewhat more complex than previous schemes it is believed that the revised framework offers flexibility and opportunities for upgrading in response to external developments and improved environmental performance across the building construction and real estate sectors, yet which is sufficiently demanding to satisfy progress and yet allow stakeholders to respond. As improved data and knowledge about the relative importance of the various environmental aspects becomes available, additional aspects can be included, the relative weighting of 'credits' refined, and the assessment criteria updated – providing that the assessment method itself provides a framework that is both comprehensive and adaptable.

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